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**ALLIANCE FOR CALIFORNIA CURRENT
ECOSYSTEM OBSERVATION
ACCEO
DRAFT GUIDELINES FOR A MONITORING PLAN**

Abstract

A marine observation system for the entire California Current pelagic ecosystem was discussed by ACCEO participants from British Columbia, California, Oregon, Washington, and Baja California (Mexico). In the course of three meetings held in 2002, participants identified the chief characteristics of such a monitoring system. This report is a synthesis of the ideas generated during the meetings. The system shall have three primary roles: 1) provide a monitoring backbone for the circulation and ocean properties of the California Current System; 2) produce a species-based pelagic ecosystem observation system based on shipboard measurements of ichthyoplankton, zooplankton, birds and marine mammals, and various bio-acoustic, bio-optical, and molecular measurements; 3) establish boundary conditions for the nearshore zone, bays and estuaries; and 4) monitor short term nearshore ocean events. The design of the observation system shall take into consideration the continuation of existing time series, resumption of historical ones, filling of major monitoring gaps in existing California Current monitoring, establishment of boundary conditions for existing monitoring programs, and monitoring of species on a population or ecosystem scale.

Background

Participants at the 2001 California Cooperative Oceanic Fisheries Investigations (CalCOFI) Conference recommended the development of a comprehensive observing system for the pelagic ecosystem of the California Current, built upon existing regional survey programs but expanded to observe the entire California Current pelagic ecosystem from British Columbia through Baja California. Such an integrated monitoring program for the Current requires building a new coast-wide monitoring consortium which would generate information benefiting communities in Canada, the U.S. and Mexico. A comprehensive California Current observation system is needed because the dynamics of current flow, marine populations and ecosystems can not be accurately interpreted from regional monitoring programs without considering the dynamics of the larger system of which each region is a part.

The Alliance for California Current Ecosystem Observation (ACCEO) monitoring characteristics outlined here were developed over the course of three community meetings held in 2002 (Monterey, California; Seattle, Washington; and Portland, Oregon). The focus of these meetings was on how best to provide a practical pelagic monitoring backbone for the California Current marine ecosystem supporting the management of its natural resources, marine reserves and sanctuaries, and protecting

human health. Participants defined the mission of ACCEO as follows:

To facilitate and coordinate monitoring of the pelagic ecosystem of the entire California Current, promote integration of California Current regional pelagic-monitoring programs to the larger benefit of all; understand the dynamics of the California Current and its populations and determine how the chemistry and biology of the California Current populations are affected by interdecadal to seasonal changes in physical forcing and water mass distributions. This effort will generate information needed for wise management of California Current natural resources, marine reserves, and protected species, and define the oceanic boundary conditions for coastal estuaries. Such boundary conditions are needed for assessment and management of human impacts on estuarine water quality and natural resources.

Monitoring Guidelines

While ocean measurements in all time and space scales are useful and complementary regardless of the particular benefit to be served, the distinctions between the scales and kinds of measurements needed for ecosystem measurement and those for other goals are important to consider. Priorities for ecosystem monitoring differ to some degree from those supporting other goals and these distinctions need to be considered in the monitoring plan. Annual trends measured over broad space and time scales have a high priority in ecosystem management. Consequently, the present value of an ecosystem measurement is extraordinarily enhanced if it can be interpreted in the context of past measurements. Ecosystem measurements need to be made at the scale of a Large Marine Ecosystem such as the California Current System (CCS). Subregions of the CCS include unknown fractions of populations which vary annually and seasonally due to changes in ocean climate. Since ecosystems are species-based, they are more costly to monitor than physical processes or bulk ocean properties where automation and remote sensing reduce costs permitting higher frequency of measurement. While high measurement frequency is essential for monitoring short term events related to human health and marine hazards, it is valuable but of lower priority for open ocean ecosystems. ACCEO participants strived to develop a design that supported, as best as possible, all potential benefits of ocean monitoring with marine ecosystems giving equal weight to other benefits. To that end, participants agreed on the following guidelines for developing an ACCEO monitoring plan:

- 1) Implementation of physical monitoring systems shall be done in concert with that for ecosystem monitoring so that the observing system is optimized for all objectives.

- 2) Canadian and Mexican representatives shall be included in the consortium to insure the integration of measurements over the entire California Current.
- 3) Fixed monitoring instruments (moorings, HF radars) or gliders shall be placed in locations that support regional needs for event scale monitoring in the nearshore zone and to provide boundary conditions for observations in bays and estuaries. These regional needs are recognized by the existence of extensive nearshore monitoring that already exists such as regional monitoring carried out by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and various sanitation districts. Also of high priority is to locate fixed instruments in a way that will link the dynamics of the nearshore zone to that of the California Current System, and to quarterly vessel surveys.
- 4) The highest priority for research vessel survey lines shall be the continuation of existing lines and resumption of historical time series. The location of NOAA Marine Sanctuaries and other marine reserves is to be taken into account in the placement of survey lines so that data can be used for measuring status, trends, and identifying unusual ecosystem events in sanctuaries and adjacent waters.
- 5) A major, long term historical gap in marine monitoring exists in the Arcata region of the northern California coast. This gap shall be filled by cooperation with Humboldt State University.
- 6) Shipboard marine bird and mammal observations shall be included in all monitoring lines in cooperation with the National Oceanic Atmospheric Administration (NOAA), Point Reyes Biological Observatory and various universities.
- 7) All data and data products will be shared in a timely manner over the internet; all data will be managed following the same protocols. They will also be made available through public outreach sites at the NOAA/Marine Sanctuary web sites and visitor centers and public aquaria such as Scripps Aquarium, Monterey Bay Aquarium, and the public wing of the Hatfield Marine Science Center (Newport).

Principal Components

Three principal components of the ACCEO monitoring alliance were identified by meeting participants: 1) species-based pelagic ecosystem monitoring system for U.S. waters; 2) Backbone oceanographic monitoring for U.S. waters including measures of flow, and water properties including nutrients, and bulk biological measurements (chlorophyll, zooplankton volume, particle standing stocks); and 3) International coordination, modeling and synthesis of California Current monitoring information involving Canada, Mexico and the U.S. Each is summarized below.

Pelagic Ecosystem observation: Major building blocks for pelagic ecosystem observations are the quarterly CalCOFI series which extend from the Mexican Border to Point Conception, the Mexican Investigaciones Mexicanas de la Corriente de California (IMECOCal) Surveys presently coordinated with CalCOFI, the Newport line off the Oregon Coast (funded by the Global Ocean Ecosystem Dynamics [GLOBEC]); and in Canadian waters, the Station P hydrographic line, and various nearshore lines along Vancouver Island. For details see map on web site <http://swfsc.nmfs.noaa.gov/FRD/acceo/presentations/p8.htm>. All of these existing monitoring lines are continuing time series, all provide standard hydrographic measurements, bulk biological measurements such as chlorophyll, zooplankton volume, and they include standard ichthyoplankton tows. CalCOFI is the only survey where marine birds and mammals are routinely identified. The goal of the ACCEO alliance shall be to standardize ecosystem observations among all existing surveys including a full suite of species observations from plankton to birds and mammals. ACCEO also proposes to enhance the existing network waters by adding ten new lines in U.S. waters which would be occupied quarterly (see survey map ACCEO web site). Included in the list of 10 is the Newport line which will no longer be supported by GLOBEC in 2004. The ten lines consist of pairs of lines located near 5 marine centers along the coast. The new lines would be occupied quarterly and synoptically and a standard minimum biological protocol would be required including zooplankton and fish species identification, bird and mammal observation, standard hydrographic measurements (nutrients, oxygen, salinity), and bulk biological properties (zooplankton volumes, chlorophyll concentration, particle volume, etc).

While most of the lines are a continuation of existing ongoing time series or the resumption of a frequently occupied line from the past, the Arcata line would monitor an area that has always been a major and significant gap in the west coast U.S. programs. In the ACCEO program, that gap will be filled through the participation of the Humboldt State University Marine program where it will be used as part of the California Center for Integrative Coastal Observation, Research and Education (CI-CORE) and used as part of instructional cruises.

Circulation and water properties: The focus of this element is to provide the monitoring backbone for the circulation of the California Current and associated water masses monitoring significant short term nearshore events on a continuous basis as well as detecting the longer term annual to decadal signals that have profound affects on the entire large marine ecosystems and its natural resources. The approach shall be a blend of autonomous ocean instruments, remote sensing, and data from quarterly cruises needed for ecosystem monitoring. These temporally and spatially limited observations from cruises will be greatly enhanced by continuous data streams from moorings, and other remote instruments (instrumented gliders, floats, buoys, HF radars, and drifters), and new remote sensing products tailored for the ACCEO observation system for the California Current. Data will be fed to ocean circulation models providing a synthetic estimate of flow, the distribution and trends in bulk ocean properties, needed interpolations between the quarterly surveys, and spatial interpolations across the major gaps between monitoring lines. Sea survey data shall also provide baseline information

on vertical structure, flow, nutrients and chlorophyll concentration needed to validate remotely sensed properties.

An important goal of ACCEO is to provide the linkage between low frequency, large scale processes of the California Current and the nearshore zone where high frequency small scale processes have more importance. ACCEO shall provide the oceanic boundary conditions and high frequency monitoring needed for the nearshore zone (0-30 m depth, 0-5 km on the open coast and estuaries, bays and harbors) which is needed to interpret better data from existing nearshore monitoring programs such as PISCO, NOAA Sanctuaries and the sanitation districts. ACCEO shall locate high frequency monitoring nodes (shelf moorings, HF radars, gliders) near existing nearshore monitoring sites and sanctuaries. These California Current monitoring nodes shall perform several vital functions for ACCEO: they provide the high frequency monitoring needed by inshore monitoring programs to help them respond to high frequency storm events, runoff and relaxation-recruitment events; permit interpretation of nearshore dynamics within the context of large scale events in the California Current; and shall assist in the interpolation between quarterly monitoring cruises.

Trinational coordination and synthesis: A critical element of the affiliation is the modeling and synthesis of data from all monitoring points to produce comprehensive products covering the entire California Current. This is inherently an international operation involving not only U.S. scientists and organizations, but those in Canada and Mexico. This component of ACCEO shall carry out these syntheses, coordinate measurements, facilitate the integration of biological and physical monitoring into useful data products and California Current status documents, and provide a forum for the discussion. A diversity of monitoring programs, organizations, and goals shall be included as participants in this monitoring affiliation ranging from the nearshore groups, University-based PISCO program, sanitation districts, and power plant groups (where monitoring is within a few kilometers of the shore) or in bays and estuaries with a focus on human and nearshore ecosystem health, to the natural resources agencies, environmental foundations, ocean hazard control groups, sanctuaries and foundations, where the focus is on populations, marine reserves, and ecosystem health. Thus, the coordination and facilitation role of ACCEO will be broad and international, as well as national.

International links shall be based on forums for discussion and coordination, scientific exchange, training, joint production of documents on the state of the California Current System and its ecosystem, and joint operation of models. All of these processes will highlight the benefits of improving local observation systems and thereby encourage increased participation by Mexico and Canada. No direct funding of observation systems in the waters of Mexico or Canada is proposed, but costs are associated with this coordinating function of the program.

Examples of Products Delivered

Portland participants gave the following examples of products that would be delivered by ACCEO.

- 1) Deliver and maintain plankton-based time series on indices of spawning biomass for key marine invertebrates and fishes of the California Current System including unexploited species, and bycatch species, as well as those taken by commercial and recreational fisheries. ACCEO time series shall link historical inventories to the present observation thereby producing trends in the spawning biomass of 200 or more species over the last 10-52 years depending on the extent of historical data. This supports fishery management and ecosystem information needs of state conservation agencies (California, Oregon, and Washington), NOAA Fisheries and NOAA's west coast Marine Sanctuary programs, Department of Fisheries and Oceans (Canada), and Instituto Nacional de Pesca [INP], Mexico).
- 2) Deliver and maintain annual time series of Marine Birds and Marine Mammal Observation. Linking present observations to past inventories supporting ecosystem management needs of Canadian, U.S. and Mexican agencies.
- 3) Routine posting on ACCEO web site of current data from the monitoring backbone for large scale California Current events, including model outputs, maps of dynamic topography from cruises and time series of environmental anomalies, and indices developed from moorings, satellite image analysis and other data sources.
- 4) Data and data products will be shared in a timely manner over the internet; all data will be managed following the same protocols. All time series for key environmental variables and abundance indices of key stocks shall be posted on the web site.
- 5) Rapid notification of ecosystem events. The public and scientific community will be alerted to changes in the ecosystem, such as anomalous changes in flow, oxygen concentration, temperature, latitudinal shifts in fauna, occurrence of new species, changes in abundance and other events, through the web site postings, direct ACCEO communication with NOAA Sanctuaries, and news releases.
- 6) Rapid Response Team. Event-triggered contact list of ACCEO experts to provide guidance and analysis in response to events such as oil spills.

Program Development

Participants recommended the creation of an ACCEO office, guided by a scientific steering committee to guide development of the program. The office would serve as the ACCEO coordination and information center, and most importantly, would coordinate the development of the cooperative monitoring network. The group also

suggested that, in addition to the development of a formal monitoring consortium, the office could facilitate the initiation of proof of concept projects. Such projects would facilitate development of a Current-wide monitoring consortium by establishing cooperative activities conducted at moderate costs that would generate synthetic utilitarian monitoring products from the beginning. The production of such products would establish collaborative pathways for processing information, and demonstrate that the ACCEO consortium can work together and produce holistic products of much greater value than the sum of current measurements. Nine topics suggested for these Current-wide proof of concept projects included:

- 1) Occupation of additional monitoring lines off the northern California and Oregon coasts as a proof of concept basis.
- 2) Create coast wide synthesis of monitoring data for eggs and larvae of pelagic species such as hake and sardine.
- 3) Coast wide synthesis of velocity field from in situ measurement and remote sensing.
- 4) A synthesis of data from PISCO, CalCOFI, GLOBEC's Newport line, and Canadian monitoring programs.
- 5) Document and monitor processes of onshore Dungeness crab megalopae transport during downwelling events.
- 6) Establishing linkages between dissolved oxygen on the shelf and that in inshore estuaries (Puget Sound and elsewhere).
- 7) An oil spill drill, an exercise to illustrate how to synthesize and focus the wide range of ocean observations on an oil spill providing trajectory and species at risk information.
- 8) Monitoring the coast-wide propagation and effects of an El Niño, including physical forcing and biological responses.
- 9) Document propagation and processes involved in 2002 cold halocline anomaly.

Outreach

Data and data products will be made available through public outreach sites at NOAA/Marine Sanctuary web sites and visitor centers and public aquaria such as the Scripps Aquarium, Monterey Bay Aquarium, and the public wing of the Hatfield Marine Science Center (Newport). Monitoring activities shall support the educational mission of the Center for Integrative Coastal Observation, Research and Education (CI-CORE) at Humboldt State University and other institutions, and shall include shipboard training in physical and biological oceanography.

Ocean monitoring research teams will be charged with the responsibility for rapid notification of significant ecosystem events, such as anomalous changes in flow, oxygen concentration, temperature, latitudinal shifts in fauna, occurrence of new species, changes in abundance and other events through the web site postings and close working relation with NOAA Sanctuaries which shall provide public access to this information.